

# Wireless Multiplexed Surface Acoustic Wave Sensors (SAW)

Completed Technology Project (2012 - 2013)



## Project Introduction

Wireless Surface Acoustic Wave (SAW) Sensor is a new technology for obtaining multiple, real-time measurements under extreme environmental conditions. The objective for this project is to develop a wireless multiplexed sensor system that uses SAW sensors, with no batteries or semiconductors, that are passive and rugged, can operate down to cryogenic temperatures and up to hundreds of degrees Celsius, and can be used to sense a wide variety of parameters over reasonable distances (meters).

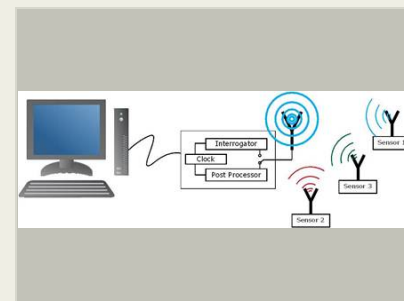
This work continues the development of a novel wireless, passive, sensing system that uses surface acoustic wave (SAW) sensors. During this effort a new multiplexing concept, coherence multiplexing, was developed and an operational system was constructed and tested. A set of wireless hydrogen sensors was tested and found to work surprisingly well. In addition, magnetic field sensors, temperature sensors, and cryogenic liquid level sensors were demonstrated. Technical progress was made on sensor performance, types of sensors, but primarily on the new coherence multiplexing scheme. Algorithms were developed, new hardware configurations developed, and sensor enhancements achieved.

## Anticipated Benefits

SAW sensors have been studied for many years, but recent work at University of Central Florida (UCF) and Kennedy Space Center (KSC) has led to multiplexing concepts that allow these sensors to be part of a wireless network. Radio frequency pulses are sent to the sensors, which produce echoes that contain both the identity of the sensor as well as the parameter being measured. These sensors are passive, rugged, small, radiation resistant, and capable of operating over a wide temperature range.

To date wireless SAW sensor systems have been demonstrated that monitor temperature, magnetic fields, hydrogen, and liquid presence while work is progressing on strain and pressure sensors. Uses range from monitoring gear temperature in an operational gear box to monitoring the level of cryogenic hydrogen, from measuring strain inside of cement to monitoring the temperature on objects on the surface of the moon.

The current emphasis has been on aerospace applications, but the wireless passive SAW radio frequency identification (RFID) and sensor concept will have a wide range of military, industrial and commercial applications. The devices are small, solid state, totally passive with no external power except interrogation energy, are radiation hard, and can be configured for ultra-wide band (UWB) operation.



Passive, Wireless Sensor System Operates by Launching of RF Pulses to the Sensors

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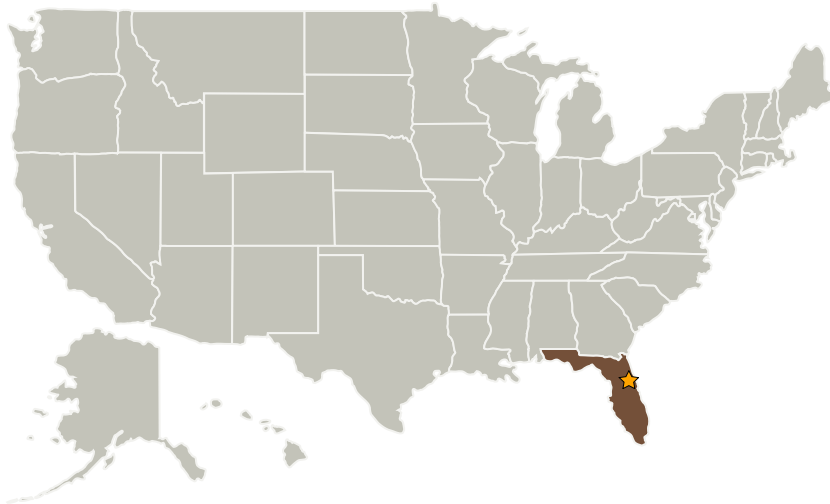
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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
Mnemonics, Inc.	Supporting Organization	Industry	Melbourne, Florida
QinetiQ North America(QNA)	Supporting Organization	Industry	
University of Central Florida(UCF)	Supporting Organization	Academia	Orlando, Florida

## Primary U.S. Work Locations

Florida

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Center / Facility:**

Kennedy Space Center (KSC)

**Responsible Program:**

Center Innovation Fund: KSC CIF

## Project Management

**Program Director:**

Michael R Lapointe

**Program Manager:**

Barbara L Brown

**Project Manager:**

Emilio Valencia

**Principal Investigator:**

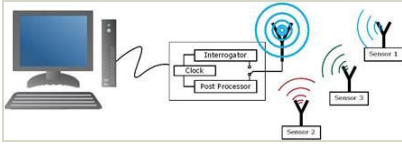
Robert C Youngquist

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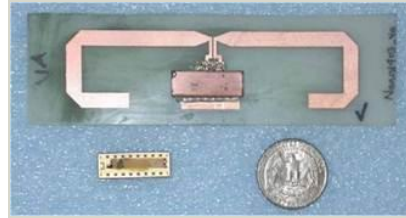
## Images



### Passive, Wireless Sensor System Operates by Launching of RF Pulses to the Sensors

Passive, Wireless Sensor System Operates by Launching of RF Pulses to the Sensors

(<https://techport.nasa.gov/image/2542>)



### Wireless Multiplexed Surface Acoustic Wave (SAW) Sensors

Wireless Multiplexed Surface Acoustic Wave (SAW) Sensors  
(<https://techport.nasa.gov/image/2194>)

## Links

Patent Pending  
(no url provided)

Institute of Electrical and Electronics Engineers (IEEE) paper: Coherence Multiplexed Passive Wireless SAW RFID Tag System  
(<http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6488615&tag=1>)

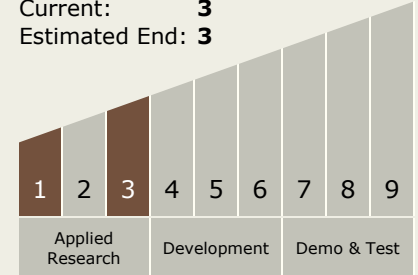
NASA Tech Briefs Webinar "Multiplexed, Wireless, and Passive Surface Acoustic Wave Sensors"  
(<http://www.techbriefs.com/component/content/article/17076>)

NTR KSC-13689 Coherence Multiplexing of Wireless Surface Acoustic Wave Sensors  
(no url provided)

NTR KSC-13827  
(no url provided)

## Technology Maturity (TRL)

Start: **1**  
Current: **3**  
Estimated End: **3**



## Technology Areas

### Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.2 Test and Qualification
    - TX13.2.7 Test Instruments and Sensors